

## IEA Bioenergy Task 34: Welcome

*By Doug Elliott, Task 34 Leader*

**The IEA Bioenergy Task 34** for Pyrolysis has been reorganized out of the former PyNe network and supports the preparation and distribution of this newsletter for the interaction of researchers with commercial entities in the field of biomass pyrolysis. Current participants in the Task are Australia, Finland and Germany with leadership provided by the U.S. This task is projected to continue in 2010 through 2012 with an expanded membership including Canada and the U.K.

### Aims & Objectives

The overall objective of Task 34 is to improve the rate of implementation and

success of fast pyrolysis for fuels and chemicals by contributing to the resolution of critical technical areas and disseminating relevant information particularly to industry and policy makers. The scope of the Task will be to monitor, review, and contribute to the resolution of issues that will permit more successful and more rapid implementation of pyrolysis technology, including identification of opportunities to provide a substantial contribution to bioenergy. This will be achieved by the activities listed below.

### Priority Topics for Task 34

|   |
|---|
| Norms and standards   |
| Analysis – methods comparison, developments, database formulation |
| Country reports updates/ Review of State of the Art               |
| Fuels and chemicals from pyrolysis                                |



Pyrolysis comprises all steps in a process from reception of biomass in a raw harvested form to delivery of a marketable product as liquid fuel, heat and/or power, chemicals

and char byproduct. The technology review may focus on the thermal conversion and applications steps, but implementation requires the complete process to be considered. Process components as well as the total process are therefore included in the scope of the Task, which will cover optimization, alternatives, economics, and market assessment.

The work of the Task will address the concerns and expectations of the following:

- Pyrolysis technology developers
- Equipment manufacturers

- Chemical producers
- Policy makers
- Investors
- Researchers
- Bio-oil application developers
- Bio-oil users
- Utilities providers
- Decision makers
- Planners

Industry will be actively encouraged to be involved as Task participants, as contributors to workshops or seminars, as consultants, or as technical reviewers of Task outputs to ensure that the orientation and activities of the Task match or meet their requirements.

This electronic newsletter is expected to be published twice a year. This is the first and only issue for 2009. Comments and suggestions for future input are invited: please contact Emma Wylde at [e.wylde@aston.ac.uk](mailto:e.wylde@aston.ac.uk)

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## Integrated Heat, Electricity and Bio-oil

### World's first integrated pyrolysis plant

Metso has built the world's first integrated pyrolysis pilot plant in Finland, in co-operation with UPM and VTT. The related concept covers the entire business chain, from feedstock purchase and pre-treatment to bio-oil production, transportation, storage and end use. This project is partly funded by TEKES,

the Finnish Funding Agency for Technology and Innovation. Integrated pyrolysis pilot plant is now in operation.

UPM is among the most important users of wood-based raw materials in Finland. The company plans to exploit the potential of several commercial pyrolysis plants in terms of bio-oil production, for its own use as well as for sale to the market, through current and future boiler investments. Metso will be able to market pyrolysis solutions to third parties in the global market. The construction of a commercial-scale demonstration plant will be planned based on the results and experiences garnered from the test runs in 2009 and 2010.

*Figure 1; A 2 MW fuel fast pyrolysis unit has been integrated with Metso's 4 MWth circulating fluidized bed boiler, located at Metso's R&D Centre in Tampere*



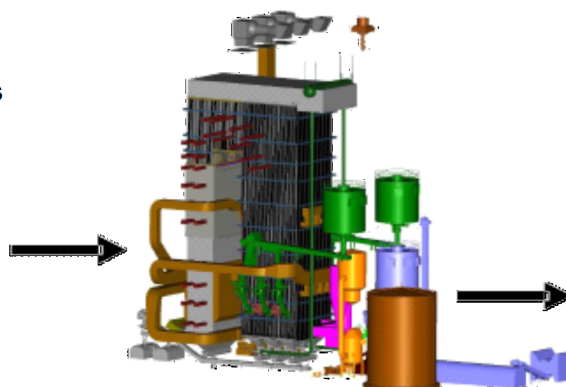
## FUEL CHAIN

Feedstock processing,  
transporting, feeding

Pyrolysis liquid production,  
solids removal by centrifugation

Pyrolysis liquid combustion  
for CHP in boilers

Forest residue, stumps



On-line moisture  
analysis

Gas on-line monitoring  
On-line analyses for  
water and solids

Water max 28 wt-%  
solids <0.05 wt-%  
single-phase liquid

## QUALITY CONTROL

*Figure 2. Standard analyses and novel on-line methods will be used through the quality control chain.*

### Integration reduces the costs

A fast pyrolysis unit can be integrated with a fluidized bed boiler. Based on such a concept, the pyrolysis unit utilizes the hot sand in the fluidized bed boiler as a heat source. The devolatilized gas compounds are condensed into bio oil and the remaining solids, including sand and fuel char, returned to the fluidized bed boiler. In the boiler, the remaining fuel char and non-condensable gases are combusted to produce heat and electricity.

### Online quality control in use

Quality follow-up along the entire chain from biomass processing via pyrolysis to oil use, will both ensure the production of a consistently high-quality product and

help in avoiding possible problems during production. Standard and novel on-line methods will be used and further developed.

### Field tests for verification

UPM's focus is on using bio-oil as a substitute for light and heavy fuel oil in heating and combined heat and power plants. Oilon developed a new burner for pyrolysis oils, this was tested in Finland this year.

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# Pyrolysis research in Australia gets a boost

## Second Generation Biofuels Research and Development Programme

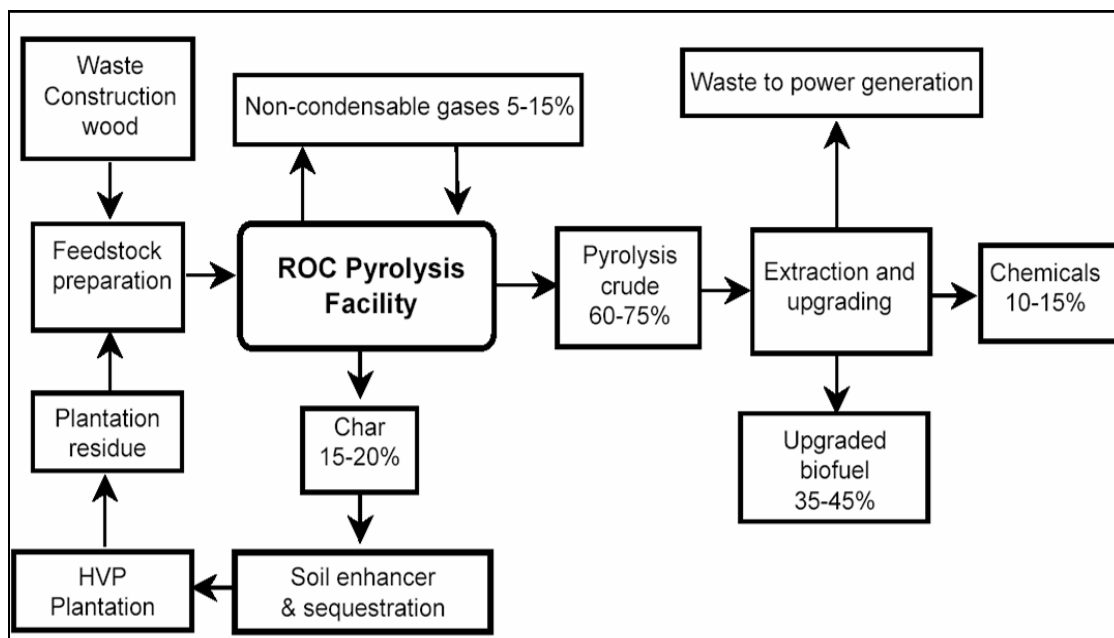
Pyrolysis research in Australia has recently received a considerable boost through the Federal Government's Second Generation Biofuels Research and Development Programme. This program is a competitive grants scheme which supports the research, development and demonstration of new biofuel technologies and feedstocks that address the sustainable development of a biofuels industry in Australia. The \$15 million Program will be delivered over three years from 2009-10 to 2011-12 as part of the Australian Government's \$4.5 billion Clean Energy Initiative. The program attracted over 30 applications in a wide range of areas, and of the seven successful program bids

two are based on pyrolysis technology.

The Curtin University of Technology project led by Professor Chun-Zhu Li will investigate the sustainable production of high quality second generation transport biofuels from oil mallee eucalyptus trees. Prof Li's team will make use of the large scale mallee plantations in the state of Western Australia which represent a considerable non-food energy resource. The overall aim of the Curtin project is to develop a novel technology for the sustainable production of high quality transport biofuels from the pyrolysis of mallee and the subsequent refining of bio-oil.

The project will also investigate the production of biochar for carbon sequestration. To achieve this, the project will integrate the feedstock-

*Figure 1: Monash/Renewable Oil Corporation (ROC) Pyrolysis Biorefinery based on sustainable use of waste construction wood and plantation timber forestry residues.*





*Figure 2: The Curtin project will make use of the oil mallee eucalyptus of which more than 14,000+ ha have been planted among the wheat crops in Western*

related and fuel production-related activities. The long term sustainability of biofuel production will be examined by tracing the nutrient, water, carbon and energy balances in the mallee crop including the option for nutrient feedback by the return of biochar to the soil. Partners in the Curtin project are Spitfire Oil Pty Ltd, WA Department of Environment and Conservation, Centre for Research into Energy for Sustainable Transport (CREST), the CSIRO and the Future Farm Industries CRC Ltd. The second project based at Monash University is jointly led by Associate Professor Damon Honnery and Professor Gil Garnier. Partnering Monash in this project is the Renewable Oil Corporation (ROC) based in Victoria.

ROC holds the exclusive Australian licence for fast pyrolysis technology from Dynamotive Energy Systems Corporation of Canada and is currently working towards establishing a 200 tonne per day pyrolysis facility in Australia. With ROC, Monash will implement pyrolysis and bio-oil upgrading technology based on that developed by Dynamotive with the aim of establishing a pyrolysis

based bio-refinery focused on fuel and chemical co-product production from construction wood waste and forestry residues.

Additional support to the project comes from Hexion Specialty Chemicals, one of the world's largest producers of industrial binders, adhesives and resins, and HVP Plantations, the largest softwood plantation operator in Australia. An important aspect of the Monash project is assessment of the ability of the upgraded fuels to replace diesel in transport engines. This will involve testing these new fuels in the Monash diesel engine test facilities to examine exhaust emissions, engine and fuel system performance. Results from these tests will be linked to detailed LCA "plantation to wheels" studies of carbon and energy flows of fuel

and co-product production and use. This work will be undertaken by a team of environmental scientists from Monash and is seen to be an integral component of fuels produced from forestry residues.

Total funding from the Second Generation Biofuels Research and Development Program for these two projects is around \$3.9 million with an additional \$3.9 million from the industry partners.

For further information on these projects contact Damon Honnery at the University of Monash, Melbourne, Australia. (damon.honnery@eng.monash.edu.au).

*Figure 3: Mallee chips ready to be feed to a pyrolysis facility.*



# Sustainable fertilisers

## Introduction

Several activities are being undertaken by the Aston University Bioenergy Research Group (BERG) within the EPSRC funded SUPERGEN Bioenergy II project to improve the sustainability of the production and use of biomass. This includes the production of several types of renewable fertiliser as summarised in Figure 1. In addition there are complementary activities by other partners in the Consortium on sustainability concerning biomass production, environmental analysis including LCA, and sustainability analysis.

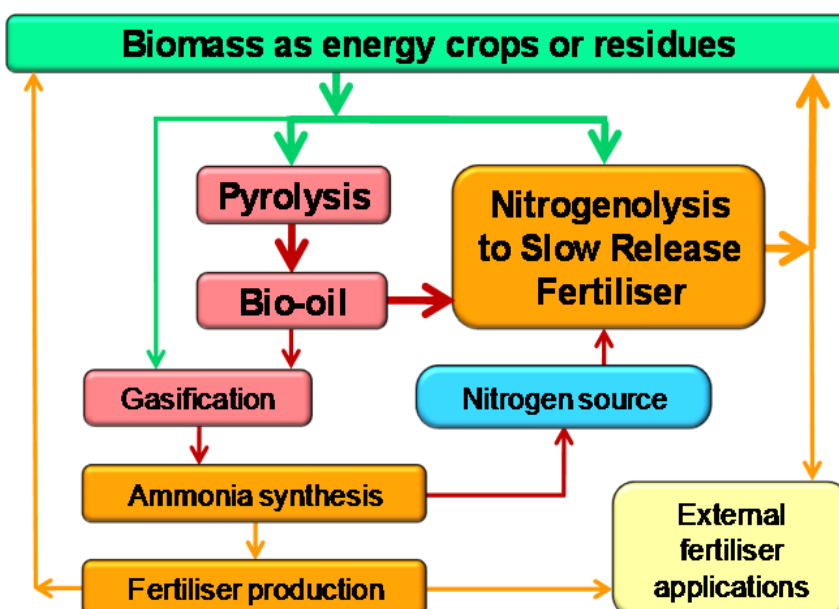
## Process routes and Products

Conventional nitrogenous fertiliser is mostly made from natural gas or other fossil fuel sources and this fossil fuel input is usually the biggest single contributor to the carbon footprint of biomass production.

Production of nitrogenous fertiliser is possible from biomass by gasification of solid biomass or liquid bio-oil followed by gas cleaning, conventional Haber based synthesis of ammonia, and conversion into a usable nitrogenous fertiliser such as urea or ammonium nitrate. Complete process systems are being modelled and subjected to techno-economic assessment to establish the costs and benefits of production of a sustainable ammonia derived fertiliser from biomass and a more sustainable bioenergy chain.

An alternative approach is nitrogenolysis of biomass which is a thermal process that combines fast pyrolysis with nitrogenation of the hot pyrolysis vapours. An extensive European Commission project in the early 2000s confirmed the feasibility of the process and established the unique properties of the products in terms of fertiliser and environmental performance. Some of the plant trials that were undertaken are shown in Figure 2.

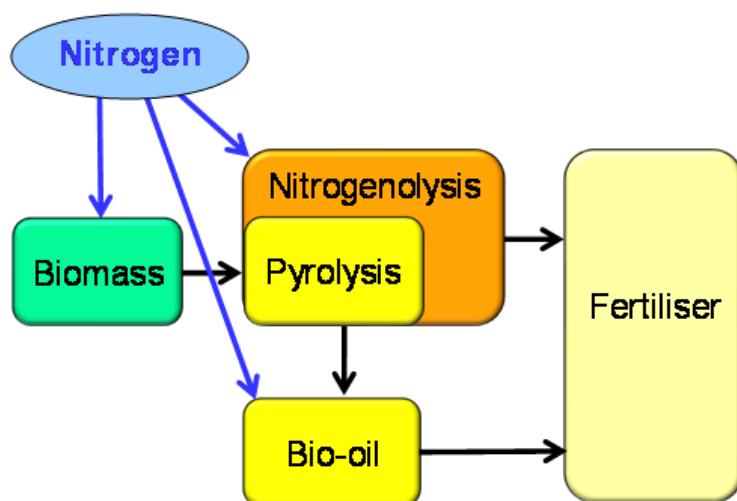
Figure 1 Routes to renewable and sustainable nitrogenous fertiliser







*Figure 2 Novel fertiliser testing trials*



*Figure 3 Methods of adding nitrogen to a fast pyrolysis process and/or product*

This work is now being continued in the SUPERGEN Bioenergy II project to improve the manufacturing process and establish optimum processing and production conditions, including testing of the resultant novel fertilisers on plants and soils. There are several ways of adding nitrogen as summarised in Figure 3.

Charcoal, or biochar as it is now widely referred to, is another product that is attracting considerable attention for several reasons: one is the carbon sequestration effect of incorporating char into soil where it will remain unchanged for millennia at least, the second is the soil conditioning effect of the

char from the physical structure, and thirdly since

the char contains all the alkali metals from the biomass, there is also a fertiliser effect. This is being considered through integration of the residual char from fast pyrolysis with the products from nitrogenolysis. Biochar is a byproduct of the fast pyrolysis process and is also made in higher yields from intermediate and slow pyrolysis processes.

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# IKERLAN-IK4 FAST PYROLYSIS PILOT PLANT: BIO-OIL AND CHAR PRODUCTION FROM BIOMASS



## Introduction

As a pre-treatment process for compacting biomass into a liquid to be sent to bio-refineries, fast pyrolysis has the potential to be a key process in the production of 2nd generation biofuels. In addition, it makes the local production of other useful chemical products possible such as fertilizers, etc.

## Ikerlan-IK4 Fast Pyrolysis pilot plant

The originality of Ikerlan-IK4 fast pyrolysis plant lies in the use of a spouted bed reactor. The viability of the spouted bed technology for pyrolysis has been demonstrated at laboratory scale by the Department of Chemical Engineering of the University of the Basque Country, which has more than 15 years of experience in the use of this technology.

The pilot plant at Ikerlan-IK4 facilities was designed for processing up to 25 kg/h of biomass, which means a significant scaling up from the work done by the University until now. The plant started running in October 2008.

The pyrolysis products pass through a quite standard separation stage composed by a cyclonic separator, a wet scrubber and coalescence filters (see figure 1). Part of the non-condensable gases that leave this stage are re-circulated and used as the fluidizing medium in the reactor, while the excess gases are burnt in a torch, where a modulating valve maintains the reactor internal pressure at near-atmospheric level.

Before entering the reactor, the fluidizing gases are heated to about 600°C by electric resistances. The



Figure 2: Spouted bed reactor

reactor walls are also heated by electrical heaters to temperatures around 700°C.

Thermal integration of the plant is still in development phase. In a second phase, the non-condensable gases will be burnt to produce the energy needed by the process.

## Performance and results

Different feeding biomass (wood chips and sawdust) are being used to test the ability of the spouted bed reactor for treating coarse and heterogeneous particulates.

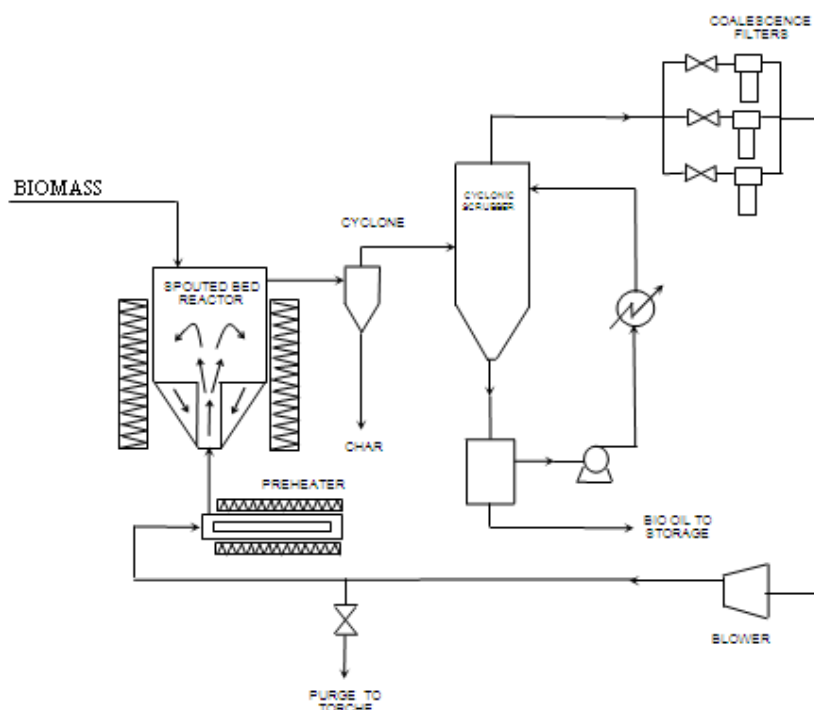


Figure 1: Pilot plant schematic



Table 1: Bio-oil properties (pine sawdust, 480°C )

| Parameter         | Unit    | Bio-oil   |
|-------------------|---------|-----------|
| HHV               | (MJ/kg) | 16        |
| Density           | (kg/l)  | 1.1-1.2   |
| Water content     | (%wt)   | 23-31 %   |
| Dynamic viscosity | (cP)    | 47 @ 25°C |
|                   |         | 33 @ 35°C |
|                   |         | 26 @ 45°C |
|                   |         | 17 @55°C  |

Table 2: Char properties (pine sawdust 480°C )

| Parameter          | Unit    | Char    |
|--------------------|---------|---------|
| HHV                | (MJ/kg) | 30      |
| Elemental analysis | (%)     | 80.4% C |
|                    |         | 3.5% H  |
|                    |         | 0.2% N  |

Inside the reactor a draft tube has been included to improve fluid bed stability and reduce fluidizing gas requirements. A ratio of "biomass fed-to-gas in recirculation" of 1 has already been achieved, with the consequent benefit on energy efficiency of the plant. Further improvement of this ratio is expected.

A typical mass balance obtained when treating pine wood sawdust at 480°C is 66% bio-oil and 13% char. Typical heating values of bio-oil and char obtained are 16 MJ/kg and 30 MJ/kg respectively. This and other properties are summarized in tables 1 and 2.

Between other possible uses, char can be used as fuel, for activated charcoal production, or can be emulsified with the bio-oil, prior to be sent to the biorefinery. Another emerging use now being

studied is as a soil improver (biochar). If it proves to be useful as soil improver char could offer, at the same time, a sensible strategy for CO<sub>2</sub> capture. IKERLAN IK-4 will collaborate for the next two years in Spanish project SOCARRAT, led by CREAM (<http://www.cream.uab.es/eng/index.htm>). The objective of this project is to test the recalcitrance and toxicological effects, in the soil and its micro-organisms, of biochars from different sources and processes, such as gasification, slow pyrolysis and fast pyrolysis of poplar and pine tree.

At IKERLAN IK4 pyrolysis plant other biomass resources will be pyrolysed in the next months and their products will be analysed in order to make a valorisation study. The process itself is on its second phase in order to use the non-condensable gases to give the heat required to the plant in a robust and efficient way.

The plant is being tested to demonstrate the possibility to produce high quality bio-oil and char from different biomass resources, in an energy efficient way.

Once, the thermal integration is concluded and mass and energy balance calculated for different biomass resources, the plant will be ready for its third phase: scaling up to its market promotion. Energy and fuels companies should take then the leading role to make bio-fuels and char production from biomass pyrolysis a reality in future.



*Figure 3: Bio-oil at Ikerlan IK-4 fast pyrolysis pilot plant*

*The authors wish to express their acknowledgement to the Basque Government and the Provincial Council of Gipuzkoa. This work has*

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## Pacific Northwest National Laboratory

Pyrolysis researchers at Pacific Northwest National Laboratory under the leadership of Doug Elliott have designed and built a fast pyrolysis system at their laboratory in Richland, Washington, USA.

Designed with input from many of our international colleagues, the heart of the system is a 1 kg/hr bubbling fluidized bed reactor that is used to support pyrolysis research as well as provide feedstock for the efforts in catalytic hydrotreating of pyrolysis oil to fuels.

The reactor is fed using two screws: first, the integrated feed screw on a stirred hopper system (Schenk Accurate) meters feed to a second, high speed screw which quickly feeds to the bottom of the fluidized bed on

a side port. The stirred hopper has been sealed to operate at 35kPa with minor leakage that is mitigated by metering nitrogen to the hopper.

Externally heated nitrogen from a custom non-contact heater is used to fluidize the sand in the pyrolysis reactor, which has operated up to 550°C. The char is separated via heated cyclones operating between 400°C and 500°C. The oil collection system consists of two spray towers followed by multiple traps. First, the gas is quenched to room temperature in a co-current, down flow spray tower circulating chilled Isopar-V hydrocarbon oil. Second, the gas is scrubbed in a countercurrent, up flow packed spray column circulating the same Isopar from a common reservoir. The vapor is further captured in a tertiary



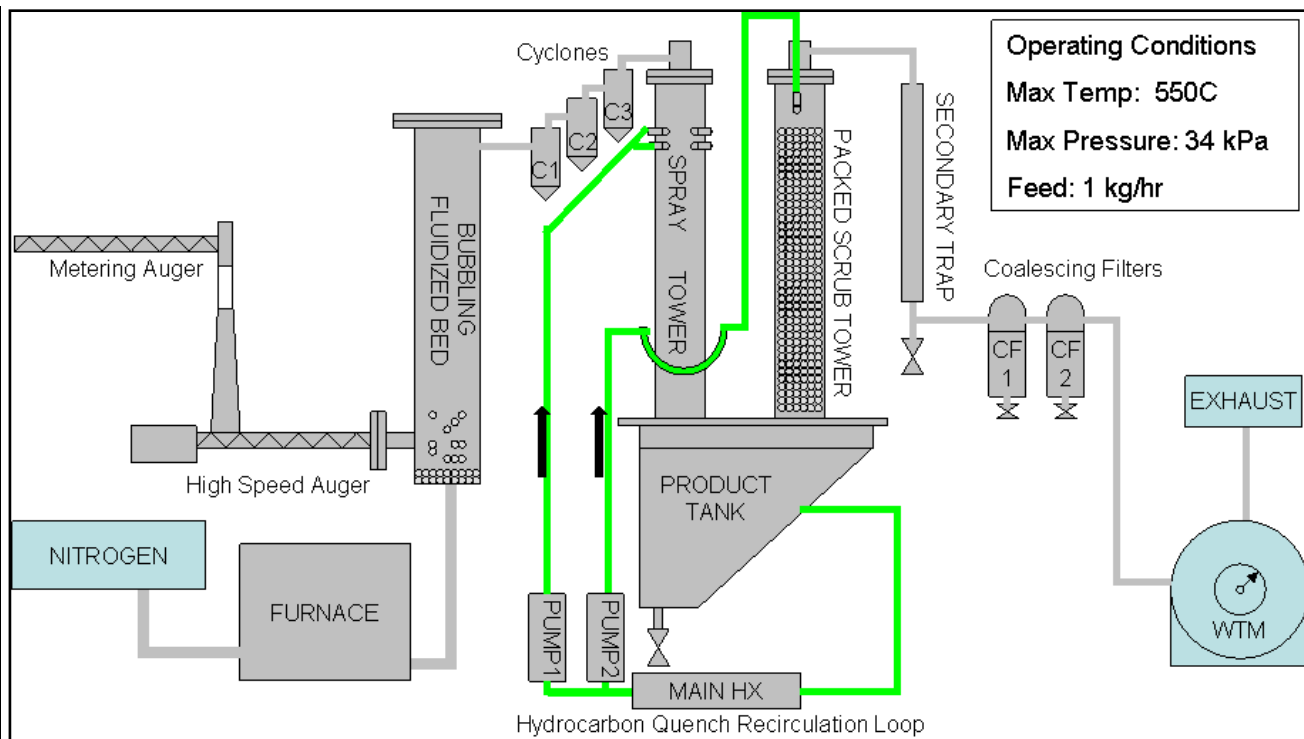


Figure 1: PNNL process flowsheet

collection tower. The remaining balance of light oil, water, and aerosolized Isopar are captured in two coalescing filters, the second of which is chilled with dry ice. The offgas is measured in a wet test meter prior to exhaust.

The system has been demonstrated with pine sawdust, maple sawdust, switchgrass, corn stover, coffee grounds, as well as some feeds provided by VTT Technical Research Centre of Finland in a collaborative effort.

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# Report of Task 34 meeting in Chicago in September 2009

Task 34 members convened in Chicago, USA, on September 15, 2009. At the meeting an agenda of numerous items were addressed as described below. The members were also able to attend the International Conference on Thermochemical Biomass Conversion Science.

## Agenda of the Task 34 Meeting

All member countries were represented by their team leaders (Douglas Elliott, US; Anja Oasmaa, Finland; Dietrich Meier, Germany; and Damon Honnery, Australia) with additional participants in supporting roles (Alan Zacher, PNNL US; Jani Lehto, METSO, Pekka Jokela, UPM, Jukka Lepälahti, TEKES, and Tuula Mäkinen, VTT Finland) and country observers from UK (Tony Bridgwater) and Canada (Fernando Petro NRCan and Stefan Mueller, Ensyn). A member of the Task 42 team was also present (Paul de Wild, ECN, The Netherlands).

## Old Business

Lignin Round Robin – the draft report had been pre-

pared and formulated into a journal submission as planned and had been submitted to the publisher. No reviews were yet available.

Annual report and Technology report – These were distributed to members earlier and were presented to ExCo by the Task leader.

## Country Reports

These were presented by representatives from Australia, Finland, Germany, and US.

Following the country reports, there was a discussion on understanding the need and target analyses for stability of bio-oil. It may be important to determine how both “quality” and “stability” of bio-oil is to be defined and assessed.

A potential Round Robin focused on the miscibility of bio-oil on the basis of feedstock and generating process was suggested. This may become valuable if bio-oil is to become a commodity.

It was suggested that there may be a need for more emphasis on modelling, as

there does not appear to be an equivalent amount of modelling work compared to historical combustion efforts.

## Norms and Standards:

### ASTM

It was reported that the ASTM burner fuel standard was approved in June and issued in September as D7544-09. There was discussion about future standards, such as refined burner fuel or for turbine, diesel fuels. There was additional discussion for the need for a stricter burner fuel standard with a tighter cap on solids content to reduce particulate emissions. However, it appears that the issue may not be well enough understood at this time, as particulate emissions can be highly dependent on burner type and configuration such that solids content analysis of the bio-oil cannot guarantee reaching a specific particulate emission target. It was deemed not needed to pursue additional standards at this time. It was suggested that it may be valuable to pursue a “P5” diesel blend standard at some point



similar to the E10 and E85 standards.

#### ANSI

Certification was discussed and deemed unnecessary.

#### REACH

The status was reviewed. Registration has been initiated with 34 companies filing (it must be a manufacturer/marketer) including many slow pyrolysis companies interested in the aqueous condensate. A lead will arise out of the group to coordinate the registration. We will continue to monitor and solicit input as needed, such as for the chemical safety report (its preparation will be a major effort). The team should expect requests for input as the final registration should be completed by October 2010.

#### CAS number

It was discussed. The situation is confused because the existing number is titled Hydropyrolysis and is more related to slow pyrolysis. The necessity for a new number was deemed uncertain. This will be followed up as it only requires a limited effort. The team should expect to see a draft description for comment.

#### MSDS

The several MSDS available need to be coordinated and probably more than one is needed. The Biotox results need to be reviewed to segregate slow and fast pyrolysis results for use in the MSDS. There was also significant discussion on the flash point of pyrolysis oil. There are distinct differ-

ences between open versus closed cup results, and there may need to be some differentiation to balance ease of shipping materials with potential liability. Aston will review the earlier effort by Cordner Peacocke on assigning a UN number for transportation use, which is also relevant and probably more important than CAS number.

#### **Topics for Group Assignment**

A task project was proposed for a lifecycle analysis on pyrolysis technology (environmental impact, greenhouse gas balance, etc.). The task would need to identify a specific, representative target pyrolysis end use and feedstock. This will require further discussion, and the end result that it may have to be 3 or 4 feedstock/application analyses. The Netherlands and Germany have national projects parallel to this effort.

#### Biorefinery assessment

The topic of lignin pyrolysis will be undertaken in Task 42 by Paul deWild of ECN. Task 34 will provide input when requested.

#### Liquid Biofuel Assessments

The task leader will follow up with Jack Saddler of Task 39.

#### Solid Waste Management

A RDF conversion workshop is being discussed in Task 36. Pyrolysis input from Task 34 will be elicited.

#### SOTA

A paper based on the country reports was discussed. No decision was reached.

#### WIKI

A site for pyrolysis data was discussed. Mississippi State University in US is developing a data base which could provide a starting point. It was suggested that good results were obtained in Task 39 with a WIKI site. The strengths and weaknesses of WIKI were discussed.

#### Analysis and methods development

The initial topic of sulfur analysis was of interest to the group. Methods will be collected for discussion and possible Round Robin initiation at the next meeting. Other methods of interest are flash point, viscosity, stability, ash, acid (pH), and GPC. VTT will be publishing a revised 450 report soon.

#### Materials

Corrosion was discussed. Only a limited amount of information is available and no quantitative information is publicly available. Oak Ridge National Laboratory in the USA may be able to do a project. Corrosion information should be sent to ORNL. The question of interest to industry is what needs to be done to allow use of carbon steel.

#### **Next meeting**

It was decided that it will be the week of April 19-23 2010, probably the 20-21 in Espoo, Finland.

# Previous Task 34 leader wins prestigious award



**Tony Bridgwater**, Professor of Chemical Engineering, has been awarded the prestigious Don Klass Award for Excellence in Thermochemical Conversion Science.

Presented to Professor Bridgwater on September 16th at the international *tcbiomass 2009* conference in Chicago, USA (see page 12), this prestigious award recognises his extensive contributions to the field of bioenergy, as well as his past efforts as organiser of World Biomass Conferences.

Globally recognised as a leading bioenergy researcher, Tony Bridgwater has worked at Aston University, Birmingham, UK, for most of his professional career and currently leads an internationally renowned research group, the Bioenergy Research Group (BERG).

Tony and his team of over 20 researchers are developing innovative processes and products whereby fast growing wood, energy crops, agricultural wastes and other biogenic materials can be thermally converted into liquids, gasses, and solids for production of electricity, heat, transport fuels and a wide variety of chemicals.

## Key achievements include:

- 45 years research experience in chemical engineering
- Founder of Bioenergy Research Group (BERG), one of the world's biggest research groups in this field
- Founder of PyNe (IEA Bioenergy Pyrolysis Network), a global forum for researchers in fast pyrolysis of biomass to exchange information on new scientific and technological developments on biomass and related technologies
- Technical Director of the UK SUPERGEN Bioenergy Consortium—the UK centre of excellence for biomass, bioenergy and biofuels
- Member of over 34 European Commission sponsored research projects, including:
  - ◇ Core member of the EC sponsored Dibanet project
  - ◇ Core member of the

Bioenergy Network of Excellence

- ◇ Core member of the EC sponsored Integrated Project on biorefineries—Biosynergy
- ◇ Co-ordinator of the EC sponsored ThermalNet Network
- ◇ Was previously Task Leader for the IEA Bioenergy Task on Pyrolysis now led by Doug Elliott
- ◇ Johannes Linneborn Prize winner in 2007 at the 15th European Bioenergy Conference for "Outstanding contributions to bioenergy"
- ◇ Edwin Walker Prize Winner—awarded by the Institution of Mechanical Engineers for "Best conference transaction publication" in 2002
- ◇ Chairman and organiser of 9 international bioenergy conferences in Europe and North America
- ◇ Publication of 30 books and over 400 papers on biomass and bioenergy



# IEA Bioenergy Tasks 34 & 42 co-operation on a lignin pyrolysis biorefinery

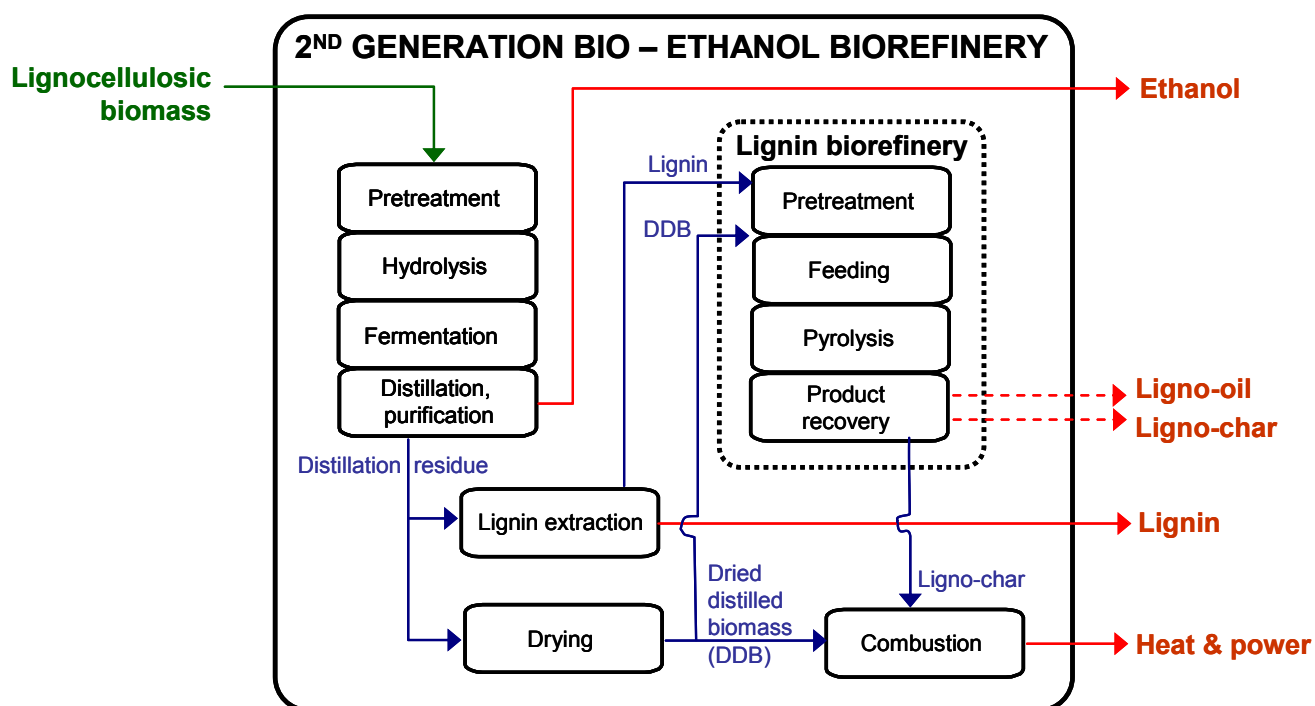
## Introduction

The major objective of Task 42 - Biorefineries is to assess the worldwide position and potential of the biorefinery concept. A biorefinery is a facility that integrates biomass conversion processes and equipment to produce fuels, power, materials and/or chemicals from biomass. By producing multiple products, a biorefinery can take advantage of the differences in biomass components and intermediates and maximize the value derived from the biomass feedstock. An important activity of Task 34 - Pyrolysis is to focus on resolution of technical issues to aid commercial implementation of fast pyrolysis, e.g. within the framework of a biorefinery. As a co-operation between Task 34 and 42, Paul de Wild (ECN, NL) will conduct a case study on lignin valorization by pyrolysis to facilitate pyrolysis-based biorefineries. Paul will join the Dutch Task 42 team for the 2010-2012 period.

## Background

At present, utilization of lignin is growing due to an increasing interest in renewable raw materials. Large amounts of lignin and lignin containing residues originate from the pulp- and paper industry. Within the biorefinery concept, the expected growth of the production capacity of second generation bio-fuels like bio-ethanol from lignocellulosic biomass will lead to another source of lignin and lignin containing residues. Despite its large potential as a significant and valuable petrochemical substitution option for fuel, performance products (polymers) and individual low molecular weight chemicals, the main practised option to date is the use as a low-cost solid fuel for generating heat. Despite its recalcitrant nature, lignin can be broken down to monomeric or low-molecular weight compounds by a variety of routes, such as alkaline oxidation or hydrolysis, alkali fusion, alkaline demethylation, hydrogenolysis, pyrolysis etc. Compared to

Figure 1 Conceptual pyrolysis based biorefinery



other routes, pyrolysis is an attractive option because it is technically relatively simple, does not need extra reactants and can be conducted under mild conditions (temperature and pressure). This simple thermochemical route breaks down lignin into low molecular weight compounds in absence of oxygen (air). However, due to the physico-chemical characteristics of lignin as a thermoplastic, thermally stable and often fine-powder-like material, and due to the non-specific nature of the pyrolysis process itself, lignin valorisation by pyrolysis is difficult. Consequently, industrial lignin pyrolysis processes are rare. To exploit the potential of lignin as a renewable feedstock for (transportation) fuels, chemicals and performance products, innovative pyrolysis technologies are needed. A successful lignin pyrolysis concept is a key asset for economic biorefineries because it enables the production of value-added materials from the main biorefinery side (waste) stream, thereby enhancing its product portfolio and process flexibility. Figure 1 presents a concept of how such a biorefinery might look like. It is loosely based on the plant shown in Figure 2: a photograph of a real bio-ethanol pilot

biorefinery (under construction) of Abengoa Bioenergy New Technologies (ABNT) near Salamanca in Spain.

### **Case Study Lignin Pyrolysis Biorefinery**

The main goal of the lignin-valorisation case study will be a techno-economic evaluation (including life cycle analysis) of the lignin pyrolysis concept both as a stand-alone facility (lignin pyrolysis biorefinery) and as an integral part of a lignocellulosic biorefinery. The approach will be aimed at a synergistic combination of literature and available (process) data from Tasks 34 and 42, e.g., experimental lignin pyrolysis data could be taken from the recently conducted Task 34 round robin on lignin fast pyrolysis. Information on the lignin-containing waste streams is available in Task 42.

### **For further information contact**

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*Figure 2 Abengoa Bioenergy New Technologies (ABNT) pilot plant for processing straw into ethanol at Salamanca in Spain*

# Events Diary

## **Sixth International Conference on Environmental, Cultural, Economic & Social Sustainability**

**Venue:** University of Cuenca, Ecuador

**Date:** 5-7 January 2010

**Web:** [www.sustainabilityconference.com](http://www.sustainabilityconference.com)

**Email:**

[lucia.astidillo@sustainabilityconference.com](mailto:lucia.astidillo@sustainabilityconference.com)

## **Energy from Biomass and Waste**

**Venue:** London, UK

**Date:** 26th January 2010

**Web:** [www.ebw-uk.com](http://www.ebw-uk.com)

**Email:** [info@ebw-uk.com](mailto:info@ebw-uk.com)

## **3rd Nordic Wood Biorefinery Conference**

**Venue:** Clarion Sign Hotel

**Date:** 22-24 March 2010

**Web:** [www.innventia.com](http://www.innventia.com)

**Email:** [birgit.backlund@innventia.com](mailto:birgit.backlund@innventia.com)

## **Task 34 Meeting**

**Venue:** Espoo, Finland

**Date:** 19-23 April 2010

**Email:** [doug.elliott@pnl.gov](mailto:doug.elliott@pnl.gov)

## **EEW Pittsburgh: bioenergy, hydrogen, & fuel cells, energy efficiency, recycling**

**Venue:** Pittsburgh, Pennsylvania, USA

**Date:** 12-16 April 2010

**Web:** [www.ee-week.com](http://www.ee-week.com)

**Email:** [info@ee-week.com](mailto:info@ee-week.com)

## **18th European Biomass Conference & Exhibition 2010**

**Venue:** Lyon, France

**Date:** 3-7 May 2010

**Web:** [www.conference-biomass.com](http://www.conference-biomass.com)

**Email:** [biomass.conference@etaflorence.it](mailto:biomass.conference@etaflorence.it)



## **WasteEng 10**

**Venue:** Beijing, China

**Date:** 17 May 2010

**Email:** [wasteeng10@home.ipe.ac.cn](mailto:wasteeng10@home.ipe.ac.cn)

## **Pyrolysis 2010: 19th International Symposium on Analytical and Applied Pyrolysis**

**Venue:** Montreal, Quebec, Canada

**Date:** 12-15 July 2010

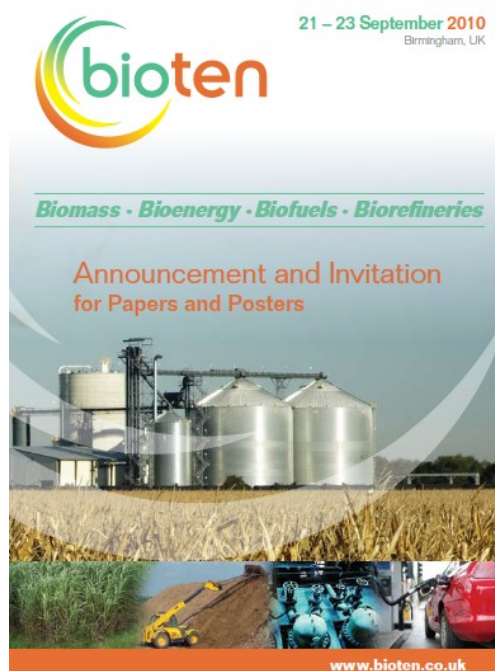
## **Bioten**

**Venue:** Birmingham UK

**Date:** 21-23 September 2010

**Email:** [c.a.manhood@aston.ac.uk](mailto:c.a.manhood@aston.ac.uk)

**Web:** [www.bioten.co.uk](http://www.bioten.co.uk)



## **Symposium on Thermal & Catalytic Science for Biofuels and Biobased Products**

**Venue:** Iowa State University

**Date:** 22-23 September 2010

**Email:** [rcbrown@iastate.edu](mailto:rcbrown@iastate.edu)

***This newsletter has been compiled by Sara Burrowes on behalf of Aston University***

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